

## RELICS OF COLORATION IN FOSSIL SHELLS.

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## PLATE XXIV.

SHELL-COLORATION, as observed among modern Mollusca, usually exists beneath the epidermis, its secretion having been effected by the border of the mantle. According to Edward Forbes,<sup>1</sup> who was one of the earliest investigators of this phenomenon, such secretion depends largely upon the action of light, so that shells found in shallow waters would be, as a rule, more brilliant than those obtained from considerable depths. His studies of the bathymetrical distribution of existing molluscs enabled him to infer that "well-defined patterns were, with very few and slight exceptions, presented only by testacea inhabiting the littoral, circum-littoral, and median zones. In the Mediterranean only one in eighteen of the shells taken from below 100 fathoms exhibited any markings of colour, and even the few that did so were questionable inhabitants of those depths. Between 35 and 55 fathoms the proportion of marked to plain shells was rather less than one in three, and between the sea-margin and 2 fathoms the striped or mottled species exceeded one half of the total number." He then surmised that, as vivid patterns are not presented by testacea living below certain depths, it might be possible to indicate, within certain limits, the depth of Palæozoic seas from a study of their molluscan fauna exhibiting traces of colour. Forbes further stated that "original colour is very rarely exhibited by fossil shells; occasionally we meet with specimens in which, owing probably to organic differences in the minute structure of the coloured and colourless portions of the shell, the pattern of the original painting is clearly distinguished from the ground tint." He also thought that as Mesozoic and Tertiary shells are closely related to existing types, there should be little difficulty in ascertaining the probable bathymetrical zone of the sea in which they lived. With regard to Palæozoic strata such calculations he considered more difficult, because the "general assemblage of articulate, molluscan, and radiate forms is so different from any now existing with which we can compare it, and so few species of generic types still remaining are presented for our guidance, that in many instances we can scarcely venture to infer with safety the original bathymetrical zone of a deposit from its fossil contents." However, after referring

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<sup>1</sup> "Report on the Mollusca and Radiata of the Ægean Sea, and on their Distribution, considered as bearing on Geology": Rep. Brit. Assoc., 1843-4, pp. 172, 173.  
 "Note on an Indication of Depth of Primæval Seas, afforded by the Remains of Colour in Fossil Testacea": Proc. Roy. Soc. Lond., vol. vii (1854), pp. 21-23.

to a number of Carboniferous shells which showed unmistakable pattern-markings derived from original colour, Forbes was of opinion that they were characteristic of molluses which had lived in a less depth of water than 50 fathoms, and he consequently considered that the Carboniferous Limestone deposit of most regions must have been a shallow-water formation.

These views were subsequently supported by Lyell,<sup>1</sup> S. P. Woodward,<sup>2</sup> and Paul Fischer,<sup>3</sup> besides being generally accepted at the present day. Gwyn Jeffreys,<sup>4</sup> however, disbelieved in this argument on the ground that some vividly coloured shells had been obtained from depths varying from 60 to 118 fathoms, including such forms as *Tapes virginica*, *Venus ovata*, and *Trochus ziziphinus*; and he was of opinion that "the extent to which light penetrates into the abysses of the ocean, as well as the mode of its transmission, does not seem to be known."

Examples of fossil shells exhibiting colour-markings are comparatively rare from the fact that chemical changes, erosion, and a variety of other causes operating during the process of fossilization, have altered to a large extent the constituent elements of the shell-structure. Whatever colours may be now apparent in such fossils they do not necessarily represent what was there in the life of the mollusc, but rather a replacement of the same has most probably resulted by subsequent colouring mediums, generated by the agencies just mentioned, which were pregnant at the time of the consolidation of the strata in which the shells are found. Such markings on fossil shells are, therefore, of interest as denoting the position and general arrangement of the colour-patterns that were characteristic of the mollusc during life.

Shell colour-markings are by no means superficial, as can be tested by examining a modern *Circe*, the valve-margins of which show that the pigment lines are sunken to about half a millimetre in depth. Thus it is that in fossil shells the colour-patterns are often preserved as finely indented lines, bands, spots, etc., which are slightly below the ordinary level of the surface.

According to Fischer's "Manuel" (p. 27), melanism and albinism are phenomena well known among the Mollusca. For instance, such genera as *Trochus*, *Turbo*, *Chiton*, *Fissurella*, *Mitra*, *Turritella*, etc., found off the west coast of South America, have a black exterior; whilst Monterosato<sup>5</sup> has noticed pronounced albinism existing amongst marine shells which live in sponges found at Tunis in Northern Africa, 35 albino forms having been observed out of a total of 120 species.

Colour remains are also met with in other organisms that are found in the fossil state. Among the Brachiopoda, for instance, may be mentioned the radiating stripes which are frequently preserved on the

<sup>1</sup> "A Manual of Elementary Geology," 5th ed. (1855), p. 410.

<sup>2</sup> "A Manual of the Mollusca," 1851, p. 46.

<sup>3</sup> "Manuel de Conchyliologie," 1880, fasc. i, p. 26.

<sup>4</sup> "British Conchology," vol. i (1862), p. xlix.

<sup>5</sup> "Notizie intorno ad alcune conchiglie delle coste d'Africa": Bull. Soc. Malac. Ital., vol. v (1880), pp. 213-233.

valves of *Dielasma hastata*, a Carboniferous member of the Terebratulidæ. According to Forbes, *Terebratula* is a genus inhabiting deep water, although the species found in modern seas having striped shells come from shallow water.

Dr. Bather<sup>1</sup> has observed coloration among fossil Crinoids, and particularly refers to one example, *Cyathocrinus acinotubus*, from the Silurian Limestone of Dudley, showing dark spots on the arms, which "may possibly be the relic of some original colouring, since similar ornament is found in recent forms." He mentions also the purple colouring in the roots of *Apiocrinus* from the Bradford Clay which he had chemically examined, besides having succeeded in extracting from such roots a large proportion of animal carbon, the presence of which he was inclined to think gave the specimens their rich colour.

Following these preliminary remarks, some examples of fossil shells will now be referred to which exhibit such markings as may be attributable to ancient coloration. Certain specimens in the British Museum have been selected for illustration, and where a particular form was not available a good published figure of the same has been copied. In illustration of the subject, some further shells are also quoted which have been suitably figured elsewhere, and which have not been reproduced on the present occasion. The species are arranged in stratigraphical order, commencing with the Cainozoic, followed by a zoological grouping.

### CAINOZOIC—Oligocene.

#### GASTROPODA.

NERITINA CONCAVA, J. de C. Sowerby. Pl. XXIV, Fig. 18.

*Neritina concava*, Sowerby: Mineral Conchology, vol. iv (1823), p. 118, pl. 385, figs. 1-8.

*Formation*.—Priabonian.

*Locality*.—Headon Hill, Isle of Wight.

It is possible that the colours frequently found in Tertiary shells may sometimes be the same as those that flourished during the life of the mollusc. The present example of the genus *Neritina* exhibits considerable variation in colour, the surface consisting of minute zigzag and lozenge-shaped markings with occasional spiral bands, the whole forming quite a lace or network combination. No two shells appear to be marked exactly the same, yet they are very abundant in the Oligocene formation and belong to one species.

This specimen is in the British Museum [G. 17999].

### MESOZOIC—Cretaceous.

#### PELECYPODA.

OSTREA cf. CURVIROSTRIS, Nilsson. Pl. XXIV, Fig. 17.

*Ostrea curvirostris*, Nilsson: Petrificata Suecana, etc., 1827, p. 30, pl. vi, fig. 5.

<sup>1</sup> Kongl. Svenska Vet.-Akad. Handl. [Stockholm], vol. xxv (1893), No. 2, p. 151.

*Formation*.—Santonian.

*Locality*.—Bromley, Kent.

Specimen consisting of the upper valve of a species probably related to Nilsson's *O. curvirostris*. The relics of coloration are represented by a few darkish bands radiating from the umbonal region and extending to the ventral margin, being considerably curved and bent during their progress over the surface of the valve.

In the British Museum [44677].

GRYPHÆA COLUMBA, Lamarck. Pl. XXIV, Fig. 16.

*Gryphæa columba*, Lamarck: Hist. Nat. Anim. sans Vert., vol. vi (1819), pt. 1, p. 198 (described from figure in Bruguière's Ency. Méthod., 1791, pl. clxxxix, figs. 3, 4).

*Formation*.—Cenomanian.

*Locality*.—Co. Antrim, Ireland.

The markings on this shell consist of dark, broad, radiating stripes, extending from the umbo to the ventral margin, being mostly arranged equidistantly, although sometimes rather irregularly or bent. Only little more than half the specimen has been figured, because the actual shell-structure is absent from the lower part of the valve; its total height measurement is 75 millimetres. All the known figures of this species show the bands reaching to the basal margin of the shell, a fact also proved by actual specimens examined from Bohemia, France, etc. These radiating stripes are indicated in Bruguière's old figures, as well as being referred to by Lamarck.

The specimen is in the British Museum [L. 14399].

PECTEN FULMINIFER, Holzapfel.

*Pecten fulminifer*, Holzapfel: Palæontographica, vol. xxxv (1889), p. 230, pl. xxvi, fig. 14.

*Formation*.—Santonian.

*Locality*.—Aix-la-Chapelle, Germany.

The specimen figured in the above work exhibits a valve with zigzag patterns, arranged longitudinally in four or five series, with regular angulations fitting into one another. The ears are decorated with oblique, crinkled markings. The figure represents an enlarged restoration made up from a fragmentary specimen.

SYNCYCLONEMA ORBICULARIS (J. Sowerby).

*Pecten orbicularis*, J. Sowerby: Min. Conch., vol. ii (1817), p. 193, pl. clxxxvi.

*Synzyclonema orbicularis*, Noetling: Palæontologische Abhandlungen (Dames & Kayser), vol. ii (1885), part 4, p. 214, pl. xviii, fig. 5.

*Formation*.—Cenomanian.

*Locality*.—Baltic regions.

Dr. Noetling figures a small example, 7 by 9 mm., of this species in the above memoir, which shows zigzag markings in longitudinal arrangement of four rows, the two lowest occupying the best half of the shell and furnished with long lines and few angulations, whilst the upper series are more broken up and form several angulations.

## CAMPTONECTES cf. CURVATUS (Geinitz). Pl. XXIV, Fig. 15.

*Pecten curvatus*, Geinitz: Versteinerungen von Kieslingswalda, 1843, p. 16, pl. iii, fig. 13.

*Formation*.—Cretaceous.

*Locality*.—Zululand, South-East Africa.

This shell exhibits two divergent bands emanating from the umbo, which may have originally extended to the ventral margin. The reddish-brown colour which the bands now present ceases about two-thirds distance from the umbo, although there are slight indications that the bands were continued to the base of the valve. From the character of the radiating ribs which curve outwards on each side the specimen appears to be closely related to *Pecten arcuatus* of Goldfuss, the supposed equivalent of the *curvatus* of Geinitz. This shell was collected by Mr. Anderson in Zululand, and is at present under description in another place. It will ultimately become the property of the British Museum.

## CYPRIINA LINEOLATA (J. Sowerby). Pl. XXIV, Fig. 14.

*Venus lineolata*, J. Sowerby: Min. Conch., vol. i (1813), p. 57, pl. xx, upper figure.

*Formation*.—Albian.

*Locality*.—Blackdown, Devonshire.

The original description states that "four-fifths of the surface [is] covered with obscure zigzag striæ." The figure now given of this shell has been drawn from Sowerby's original specimen in the British Museum [43104]. Parkinson first referred it to *Venus castrensis* of Linnæus, but Sowerby pointed out that it differed from the Linnæan shell, and therefore changed the specific name as above. Parkinson's description mentioned that it "is perfectly silicified, and in the transparent parts the angulated tent-like characters are beautifully shown in white and opaque markings" ("Organic Remains of a Former World," vol. iii, 1811, p. 187). Another specimen in the British Museum [L. 17209] shows the chevron pattern as a series of well-indented lines.

Although up to the present time the zigzag striæ of this shell have been referred to as part of the sculpture, it seems more than probable that they are attributable to a former coloration. The V-shaped patterns, although obscure in places, are seen to cover the valve, with the exception of the posterior side; they are of darker colour than the ordinary ground tint, having all the appearance of being still filled with a material which might represent the pigment originally secreted by the mollusc, but under considerably altered mineralogical conditions.

## MESOZOIC—Oolite.

## GASTROPODA.

## NATICA CINCTA, Phillips. Pl. XXIV, Fig. 12.

*Natica cincta*, Phillips: Illustrations of the Geology of Yorkshire, Yorkshire Coast, 1829, p. 130, pl. iv, fig. 9.

*Formation*.—Bathonian.

*Locality*.—Stratton, Gloucestershire.

This specimen represents the body-whorl of *Natica cineta*, on which is clearly depicted a series of nearly equidistant, black, divergent markings, extending from the suture to the basal margin, the apices of the angles pointing inwards or away from the margin of the mouth. The test of this specimen is ornamented with a series of closely arranged longitudinal striations. A recent form of this genus, *Natica fulminea* of Gmelin, shows zigzag colour-markings, but they are less regular, smaller, and more complicated than in the fossil example now figured.

The specimen is in the British Museum [G. 1604].

*PSEUDOMELANIA HEDDINGTONENSIS* (J. Sowerby). Pl. XXIV, Fig. 13.

*Melania Heddingtonensis*, J. Sowerby: Min. Conch., vol. i (1813), p. 86, pl. xxxix, right- and left-hand figures.

*Chemnitzia Heddingtonensis*, D'Orbigny: Paléontologie Française, Terrains Jurassiques, Gastéropodes, 1850, p. 56, pl. ccxlv, figs. 4, 5.

*Pseudomelania Heddingtonensis*, Hudleston: "A Catalogue of British Jurassic Gasteropoda," 1892, p. 111.

*Formation*.—Oxfordian.

*Locality*.—France.

A number of regularly spaced, well-indented, zigzag markings occur in longitudinal rows on the later whorls of this species, when favourably preserved; British examples, however, seldom show these indications of colour-remains. A reproduction of D'Orbigny's figure 4 is given on the present plate. The original remarks in connection with the curious zigzag patterns are as follows:—"Ses couleurs dont on juge par les lignes d'altération de sa surface forment des linéoles ondulées, ou des zigzags en long."

*PSEUDOMELANIA* cf. *LINEATA* (J. Sowerby).

*Melania lineata*, J. Sowerby: Min. Conch., vol. iii (1818), p. 33, pl. ccxviii, fig. 1.

*Melania Heddingtonensis*, Deslongchamps: Mém. Soc. Linn. Normandie, vol. vii (1842), p. 225, pl. xii, figs. 9, 10; non Sowerby.

*Formation*.—Bajocian.

*Locality*.—Normandy, France.

An elaborate figure of a so-called *Melania Heddingtonensis* was published by Deslongchamps in 1842 (fig. 10 of his plate), drawn from an example found in the Bajocian rocks of Les Moutiers, Normandy, in which is depicted, on a kind of cream-coloured groundwork, numerous reddish-brown streaks of various forms arranged both transversely and longitudinally, some bifurcating into fine lines, whilst many take a zigzag course. According to these figures, this complicated coloration exists from the apex of the spire to the margin of the mouth. This specimen has a length of 85 mm.

It was subsequently pointed out by D'Orbigny that Deslongchamps was in error as to the specific determination of this shell (Paléontologie Française, Terrains Jurassiques, Gastéropodes, 1850, p. 57), and he

was of opinion that it would be more correctly referred to *Melania lineata* of J. Sowerby, another recognized form of *Pseudomelania*, more especially as the true *Heddingtonensis* was restricted to Oxfordian and Corallian times. For present reference purposes the shell is recognized as having affinities with the Sowerbyan species, *lineata*.

*PSEUDOMELANIA COARCTATA* (Deslongchamps).

*Melania coarctata*, Deslongchamps: Mém. Soc. Linn. Normandie, vol. vii (1842), p. 226, pl. xii, figs. 11, 12.

*Pseudomelania coarctata*, Huddlestone: Mon. Pal. Soc. (British Jurassic Gasteropoda), 1892, p. 242.

*Formation*.—Bajocian.

*Locality*.—Normandy, France.

The two original figures of this species represent most gorgeously coloured shells, the groundwork being of cream colour, on which are large reddish-brown patches arranged longitudinally and giving off thin streaks, which bifurcate, trifurcate, and even further split up, looking frequently like a series of antlers. Zigzag patterns are also observable, especially on the body-whorl of Deslongchamps's figure 12.

The longest of these specimens measures 103 mm.

PELECYPODA.

*SYNCYCLONEMA DEMISSA* (Phillips).

Var. *INUTILIS*, Whidborne.

*Pecten demissus*, Phillips: Illust. Geol. Yorkshire, Yorkshire Coast, 1829, p. 140, pl. vi, fig. 5.

*Pecten demissus*, var. *inutilis*, Whidborne: Quart. Journ. Geol. Soc., vol. xxxix (1883), p. 499, pl. xv, fig. 15.

*Formation*.—Bajocian.

*Locality*.—Yeovil Junction.

A valve of this shell (length 35, height 35 mm.) is described as being covered with "beautiful zigzag colour-markings" in longitudinal arrangement. Mr. Whidborne, in the monograph above quoted, also refers to a number of further English Jurassic shells exhibiting relics of coloration, which the student would do well to examine.

PALÆOZOIC—Carboniferous.

CEPHALOPODA.

*MELOCERAS ACUS* (Koninck).

*Cyrtoceras acus*, Koninck: Ann. Mus. Roy. Hist. Nat. Belgique, vol. v (1880), pt. 2, p. 28, pl. xxxv, fig. 6.

*Meloceras acus*, A. H. Foord: Cat. Fossil Cephalopoda British Museum, pt. i, Nautiloidea, 1888, p. 307.

*Formation*.—Bernician.

*Locality*.—Belgium.

This Cephalopod possesses chevron-shaped markings arranged longitudinally. An example of this species is in the British Museum [64837], but the markings are somewhat obscure.

## GASTROPODA.

CAPULUS MARGARITA, G. S. Boulger. Pl. XXIV, Fig. 5.

*Capulus margarita*, Boulger: Proc. Geol. Assoc., vol. xi (1890), p. 445, pl. iv, figs. 1-3.

*Formation*.—Bernician.

*Locality*.—Ayrshire.

This interesting fossil was originally described as "showing dark olive green colour-bands radiating from the apex of the spire." Mr. Boulger's figure 1, representing a natural sized drawing of the original specimen, is reproduced on the present plate.

PLATYOSTOMELLA SCOTOBURDIGALENSIS, R. Etheridge, jun. Pl. XXIV, Figs. 6, 7.

*Platystomella Scotoburdigalensis*, Etheridge: Proc. Roy. Phys. Soc. Edinburgh, vol. v (1880), p. 161, pl. iii, figs. 1-6.

*Formation*.—Bernician.

*Locality*.—Fifeshire.

Mr. Etheridge, jun., described this species more than a quarter of a century since, as "a small Naticiform Gastropod showing colour-bands." These colour-remains were found to be very variable, the bands occurring in pairs and also singly, being arranged both spirally and longitudinally, whilst one of the examples showed no bands at all. Figs. 6 and 7 of this paper, copied from Etheridge's original plate, illustrate the single-banded character and also the twinned condition observed in some examples of the species. The specimens are extremely small from the fact that the figures are said to be ten times enlarged.

MOURLONIA CARINATA (J. Sowerby). Pl. XXIV, Fig. 4.

*Helix carinatus*, J. Sowerby: Min. Conch., vol. i (1812), p. 34, pl. x, upper and lower figures.

*Pleurotomaria flammigera*, Phillips: Illust. Geol. Yorkshire, pt. ii, The Mountain Limestone District, 1836, p. 226, pl. xv, fig. 2.

*Pleurotomaria carinata*, J. de C. Sowerby: Min. Conch., vol. vii (1844), p. 70, pl. 640, fig. 3.

*Mourlonia carinata*, Koninck: Ann. Mus. Roy. Hist. Nat. Belgique, vol. vii (1883), pt. 4, p. 77, pl. xxxiii bis, figs. 4, 5.

*Formation*.—Bernician.

*Locality*.—Yorkshire.

Phillips originally referred to this Pleurotomaroid shell by stating "colour varied with zigzag flashes." The markings mostly occur on the surface of the body-whorl and above the so-called band which characterizes this group of shells; only rarely are they seen below that structure. They consist of thick zigzag stripes, more or less equally spaced, regular, and arranged transversely, and between them can be seen the fine striations which form the sculpture of the shell.

The zigzag markings were not present on the specimen selected for illustration when James Sowerby published his account of this species. In the meantime Phillips issued a remarkably good figure, showing these remains of ancient coloration, and referred his specimen to the



then new specific name, *flammigera*. Subsequently James de Carle Sowerby completed the history of his father's species by publishing another figure of this shell which included the peculiar zigzag markings. In this representation it is noticeable that the stripes are seen to occur beneath the encircling band as well as above it. The later Sowerby also recognized that Phillips's *flammigera* was synonymous with the earlier *carinata*.

The late Professor L. de Koninck included this species in his genus *Mourlonia*. The specimen now figured has been slightly restored on account of its basal contour being more or less fractured in places.

The specimen is in the British Museum [G. 130].

## PELECYPODA.

SYNCYCLONEMA SOWERBYI (McCoy). Pl. XXIV, Fig. 11.

*Pecten Sowerbyi*, McCoy: "A Synopsis of the Characters of the Carboniferous Fossils of Ireland," 1844, p. 100, pl. xiv, fig. 1.

*Formation*.—Bernician.

*Locality*.—Kildare, Ireland.

This valve is furnished with about eight fairly stout, divaricating bands, extending to both the anterior and posterior margins and equally divided from each other, the apices of the angles being quite central and directed dorsally. The bands form slightly roughened grooves, as if the pigment material which originally filled them had decomposed on account of its constituents being of a softer nature than the shell-structure itself. Fine and closely-arranged concentric striations are also present on this valve, forming its sculpture. McCoy's original figure obscurely indicates the presence of such bands, although they were not referred to in the descriptive text.

From a later study of the species McCoy found that by removing the top, very thin, superficial layer of the shell he disclosed "a number of small, interrupted zigzag and divaricating, scratch-like markings" ("Systematic Description of the British Palæozoic Fossils," 1855, p. 478).

Mr. Etheridge, jun., subsequently made a study of the shell (Geol. Mag., 1874, p. 300, pl. xiii, figs. 1, 2), especially in connection with the peculiar V-shaped markings or grooves, referred to by McCoy, and which he stated occurred on the "inner lamina of the shell."

Another important contribution in connection with this species was the re-figuring of McCoy's original specimen by W. H. Baily ("Figures of Characteristic British Fossils," 1875, p. 113, pl. xxxix, fig. 3), who directed attention to the "wavy bands of colour-markings in addition to the concentric lines of growth." The markings, of which seven can be counted on the figure, were stated to be of a "burnt umber colour."

The shell evidently exhibits considerable variation so far as these markings are concerned. A specimen in the British Museum [30355] possesses more than twenty divaricating bands stretching across the valve, although near the basal margin these appear to be replaced by a number of zigzag striæ; and all these patterns are well indented.

From an examination of a number of specimens exhibiting these different patterns and their comparison with the colour-markings of modern shells, there can be little doubt that they represent the remains of original coloration. Dr. Wheelton Hind is followed in regarding this species as belonging to *Syncyclonema* (Mon. Pal. Soc., "British Carboniferous Lamellibranchiata," 1903, p. 118, pl. xviii, figs. 21-26).

The specimen now figured is in the British Museum [30346].

SYNCYCLONEMA COLORATA (Koninck).

*Entolium coloratum*, Koninck: Ann. Mus. Roy. Hist. Nat. Belgique, vol. xi (1885), pt. 5, p. 241, pl. xxxii, fig. 21.

*Formation*.—Bernician.

*Locality*.—Belgium.

This specimen is a pectinoid valve bearing a series (about 18 rows) of longitudinally arranged, zigzag patterns, which fit into one another, but having equal spaces of separation. The actual surface structure is quite smooth, and not ornamented with concentric striations. The dimensions of the specimen are: length 33, height 44 mm.

AVICULOPECTEN RUGULOSUS (McCoy). Pl. XXIV, Fig. 10.

*Pecten rugulosus*, McCoy: "A Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland," 1844, p. 98, pl. xvii, fig. 7.

*Formation*.—Bernician.

*Locality*.—Kildare, Ireland.

More than a dozen dark spots are observed on the umbonal half of this (right) valve. They are of nearly equal size, covering mostly about three ribs, and are rather more elongate than round. This colour feature is extremely rare among Palæozoic pectinoid shells, and was very early noticed by Edward Forbes in connection with a specimen he had examined in the Museum of Practical Geology, Jermyn Street, referring to it as an unnamed species of *Aviculopecten* showing "spotty markings on the ribs in the manner of many existing *Pectines*" (Proc. Roy. Soc. London, vol. vii, 1854, p. 23).

The specimen is in the British Museum [30,348].

STREBLOPTERIA SUBLOBATA (Phillips). Pl. XXIV, Figs. 8, 9.

*Avicula sublobata*, Phillips: Illustrations of the Geology of Yorkshire, Mountain Limestone District, 1836, p. 211, pl. vi, fig. 25.

*Formation*.—Bernician.

*Locality*.—Derbyshire.

The radiating brownish bands, representing the original colour-markings so frequently seen on this shell, have been ably described by Mr. R. Etheridge, jun. (Geol. Mag., 1876, p. 152, pl. vi, figs. 2-6), who recognized considerable variation, one valve possessing as few as six or seven, another showing fourteen or fifteen, and all passing from the umbo to the margin in a straight course. They sometimes differ in width, the central ones being broadest. Both bifurcation and trifurcation exist in some examples, whilst a smaller band is

occasionally found between the larger ones. The larger of the two specimens here figured shows six bands on the right valve, the four centrals being nearly equidistant or paired, whilst the laterals are more widely separated. These bands are narrow and fine from the umbonal region, but gradually thicken in their descent to the ventral margin, where they are observed to be of equal width. The opposing valve of this specimen possesses only two bands, and these are in the centre. The smaller specimen starts with about seven primary bands which bifurcate soon after leaving the umbonal area, then continue their course to the margin in well-arranged pairs; a short, isolated band occasionally occurs in the spaces separating the couples. This species is recognized as belonging to McCoy's genus *Streblopteria*, first suggested by Mr. Etheridge, jun., although it is only right to mention that Dr. Wheelton Hind places it in *Pseudamusium* (Mon. Pal. Soc., 1903, "British Carboniferous Lamellibranchia," p. 110).

Both the specimens figured are in the British Museum [L. 10072] and come from Derbyshire. Further excellent examples of this species exhibiting similar remains of ancient colour-markings are also in the British Museum and localized as from Yorkshire and Ireland; one of these has the stripes or bands following a triplicate arrangement [L. 19679].

## PALÆOZOIC—Devonian.

### CEPHALOPODA.

ORTHOCERAS ANGULIFERUM, Archiac & Verneuil. Pl. XXIV, Fig. 2.

*Orthoceras anguliferum*, Archiac & Verneuil: Trans. Geol. Soc. London, vol. vi (1842), p. 346, pl. xxvii, fig. 6.

*Formation*.—Eifelian.

*Locality*.—Paffrath, Germany.

The figure on the present plate is taken from the original illustration. The entire surface of the specimen is seen to be covered with a number of regularly sinuated markings arranged longitudinally, thus forming a beautiful chevron pattern.

### GASTROPODA.

NATICOPSIS HARPULA (J. de C. Sowerby). Pl. XXIV, Fig. 3.

*Murex harpula*, J. de C. Sowerby: Min. Conch., vol. vi (1827), p. 152, pl. 578, fig. 5.

*Nerita subcostata* (Goldfuss MS.), Bronn: Lethæa Geognostica, 2nd ed., vol. ii (1838), p. 1282 (non *Buccinites subcostatus*, Schlotheim, 1822).

*Natica subcostata*, Archiac & Verneuil: Trans. Geol. Soc. London, ser. II, vol. vi (1842), p. 366, pl. xxxiv, figs. 5, 6. Goldfuss: Petrefacta Germaniæ, vol. iii (1844), p. 116, pl. cxviii, fig. 22.

*Naticopsis harpula*, Whidborne: Mon. Pal. Soc., 1891, p. 189, pl. xix, figs. 3, 4.

*Formation.*—Eifelian.

*Locality.*—Paffrath, Germany.

The figure given of this form is copied from Archiac & Verneuil's work, pl. xxxiv, fig. 5, which represents a specimen from the Devonian rocks of Paffrath, Rhenish Germany. It shows three distinct transverse rows of what are stated to be "brown spots" forming "the remains of the colouring matter of the shell." A much larger example from the same locality is in the British Museum with the markings equally well preserved as are exhibited in the figure. This species also occurs in the Devonian rocks of England, but no specimens that have been examined have any relics of the colour-spots remaining.

The determination and synonymy of this shell are taken from Mr. Whidborne's "Monograph of the Devonian Fauna of the South of England."

## PALÆOZOIC—Silurian.

### CEPHALOPODA.

ORTHOCERAS ANNULATUM, J. Sowerby.

*Orthoceras annulatum*, J. Sowerby: Min. Conch., vol. ii (1818), p. 73, pl. cxxxiii.

*Formation.*—Wenlockian.

*Locality.*—Wenlock.

The late Professor J. F. Blake called attention some years since to a specimen of this species in the Museum of Practical Geology showing straight longitudinal colour-bands, which were stated by Mr. A. H. Foord ("Catalogue of the Fossil Cephalopoda in the British Museum (Natural History)," part i, Nautiloidea, 1888, p. 54) to be very distinct. Blake's published figure, however, of this specimen is not particularly convincing as an example of colour-banding ("British Fossil Cephalopoda," 1882, p. 91, pl. iv, fig. 4), although of interest to refer to on the present occasion.

### GASTROPODA.

POLYTROPINA HELICINA (Lindström). Pl. XXIV, Fig. 1.

*Oriostoma helicinum*, Lindström: Kongl. Svenska Vet.-Akad. Handlingar, Stockholm, vol. xix (1884), No. 6, pl. xx, figs. 30, 31.

*Formation.*—Ludlovian.

*Locality.*—Gothland, Sweden.

A small form of Gastropod exhibiting transverse bands of colour at regular distances, parallel with the sculpture lines. Fig. 30 of the original plate has been copied for this paper; it represents a specimen having a height of 10 mm., the illustration being made twice natural size. According to Lindström the Gothland Silurian deposits contain a littoral fauna.

The species is here referred to *Polytropina* of Miss Jane Donald (now Mrs. Longstaff), who founded this generic name to replace

Lindström's *Oriostoma*, which the authoress correctly discovered was entirely different to Munier-Chalmas's shell of the same name and earlier date (Quart. Journ. Geol. Soc., vol. lxi, 1905, p. 575).

CYRTOBITES PHARETRA, Lindström.

*Cyrtolites pharetra*, Lindström: Kongl. Svenska Vet.-Akad. Handlingar, Stockholm, vol. xix (1884), No. 6, p. 83, pl. vi, fig. 39.

*Formation*.—Ludlovian.

*Locality*.—Gothland, Sweden.

Specimen showing spiral or longitudinal colour-bands; a transverse, ridge-like ornamentation forms the sculpture of the shell.

Lindström's shell is said to measure 15 mm. in length, the published figure being enlarged three times.

EXPLANATION OF PLATE XXIV.

- FIG. 1. *Polytropina helicina* (Lindström). Silurian, Sweden. Copied from original figure.  $\times 2$ .
- „ 2. *Orthoceras anguliferum*, Archiac & Verneuil. Devonian, Germany. Copied from original figure.
- „ 3. *Naticopsis harpula* (J. de C. Sowerby). Devonian, Germany. Copied from original figure (pl. xxxiv, fig. 5) of Archiac & Verneuil's *Natica subcostata*.
- „ 4. *Mourlonia carinata* (J. Sowerby). Carboniferous, Yorkshire. Drawn from a specimen in the British Museum [G. 130].
- „ 5. *Capulus margarita*, Boulger. Carboniferous, Ayrshire. Copied from original figure (fig. 1).
- FIGS. 6, 7. *Platystomella Scotoburdigalensis*, R. Etheridge, jun. Carboniferous, Fifeshire. Exhibiting both the single and the twinned stripes. Copied from original figures (figs. 1a and 2).  $\times 10$ .
- „ 8, 9. *Streblopteria sublobata* (Phillips). Carboniferous, Derbyshire. Exhibiting both the single and the twinned stripes. Drawn from specimens in the British Museum [L. 10072].
- FIG. 10. *Aviculopecten rugulosus* (McCoy). Carboniferous, Kildare, Ireland. Drawn from a specimen (right valve) in the British Museum [30348].
- „ 11. *Syneclonema Sowerbyi* (McCoy). Carboniferous, Kildare, Ireland. Drawn from a specimen in the British Museum [30346].
- „ 12. *Natica cineta*, Phillips. Great Oolite, Stratton, Gloucestershire. Drawn from a specimen, with only the basal whorl preserved, in the British Museum [G. 1604].
- „ 13. *Pseudomelania Heildingtonensis* (J. Sowerby). Oxfordian, France. Copied from Orbigny's interpretation of this species (pl. cexliv, fig. 4).
- „ 14. *Cyprina lineolata* (J. Sowerby). Cretaceous, Blackdown, Devonshire. Drawn from the original specimen (a right valve) in the British Museum [43104].
- „ 15. *Camptonectes* cf. *curvatus* (Geinitz). Cretaceous, Zululand. Drawn from a specimen (left valve) collected by Mr. William Anderson, F.G.S.
- „ 16. *Gryphæa columba*, Lamarek. Cretaceous, co. Antrim, Ireland. This figure includes rather more than the half of a large specimen (lower valve) in the British Museum [L. 14399].
- „ 17. *Ostrea* cf. *curvirostris*, Nilsson. Cretaceous, Bromley, Kent. Drawn from a specimen in the British Museum [44677].
- „ 18. *Neritina concava*, J. de C. Sowerby. Oligocene, Isle of Wight. Drawn from a specimen in the British Museum [G. 17999].  $\times 2$ .

The figures on this plate, unless otherwise marked, are drawn natural size.